



Federal Aviation Administration

Memorandum

Date: November 29, 2007

To: Manager, Small Airplane Directorate, ACE-100

From: Manager, Wichita Aircraft Certification Office, ACE-115W

Prepared by: Daniel Hilton, Electrical Systems & Avionics Branch, ACE-119W

Subject: Equivalent Level of Safety to § 23.1397(c); Cessna Aircraft Company, Models 172R, 172S; Finding No. ACE-07-10

This memorandum requests your office to review and provide concurrence with the proposed finding of equivalent level of safety (ELOS) to the aviation white color requirements of 14 CFR part 23, § 23.1397(c).

BACKGROUND:

The navigation light requirements are addressed in 14 CFR part 23, §§ 23.1385, 1387, 1389, 1391, 1393, 1395 and 1397. These requirements cover intensities, color specifications and field of coverage. The calculations for light colors and light intensity are derived for incandescent lights and may not be directly applicable to Light Emitting Diode (LED) technology.

Cessna Aircraft Company intends to certify a new technology LED based rear position light including lens cover on the Cessna Models 172S and 172R. This proposed position light with lens cover is identified as Whelen Model 71011 series. The 14 CFR part 23, § 23.1397(c) Amendment 23-N/C, (which is included in the certification basis of the aircraft) prescribes chromaticity requirements that effectively define the color Aviation White. Cessna Aircraft Company has applied for an equivalent level of safety finding with § 23.1397(c) Amendment 23-N/C and requests Federal Aviation Administration (FAA) consideration of this design feature.

APPLICABLE REGULATIONS:

Section 23.1397(c) amendment N/C contains specific chromaticity compliance requirements that single engine, normal, utility, acrobatic, or commuter category airplanes must demonstrate. This regulation contains specific chromaticity requirements for the color aviation white. The applicant must provide an equivalent level of safety with sufficient compensating factors, or factors for color compliance, if their proposed design is different than what is prescribed in this regulation.

REGULATIONS REQUIRING AN ELOS:

In considering the current design, the applicant has requested an ELOS for an LED based rear position light design using the design requirements of TSO C30c and the FAA has determined that an appropriate level of safety can be provided by the issuance an ELOS, in accordance with the provisions of 14 CFR, part 21, § 21.21(b)(1).

DESCRIPTION AND EXPLANATION OF COMPENSATING FEATURES:

The 14 CFR part 23, § 23.1397 (c), Amendment 23-N/C requirement states that the light color must have applicable International Commission on Illumination chromaticity coordinates. In the regulation these requirements are expressed as:

“x” is not less than 0.350;

“x” is not greater than 0.540; and

“y-y₀” is not numerically greater than 0.01, “y₀” being the y coordinate of the Planckian radiator for which x₀=x.

The TSO color requirements are contained in AS8037 paragraph 3.3.1. They are expressed in terms of color boundary as:

Aviation White

Yellow Boundary	$x = 0.500$
Red Boundary	$y = 0.382$
Purple Boundary	$y = 0.047 + 0.762x$
Blue Boundary	$x = 0.285$
Green Boundary	$y = 0.150 + 0.640x$
and	$y = 0.440$

The diagram (Figure 1) shows the boundary of the 14 CFR part 23, § 23.1397 (c), Amendment 23-N/C requirements and the boundary permitted by TSO-C30c. The TSO boundary, dictated by the AS8037 requirements has a significant overlap with the 14 CFR part 23, § 23.1397 (c), Amendment 23-N/C requirements, however, there are portions of the two requirements that do not overlap. Since the requirement to produce the lights is defined by AS8037, Cessna believes that while some light assemblies might meet the requirements of 14 CFR part 23, § 23.1397(c), per Amdt. 23-N/C, others might only meet the requirements dictated by the TSO which would result in non-compliance.

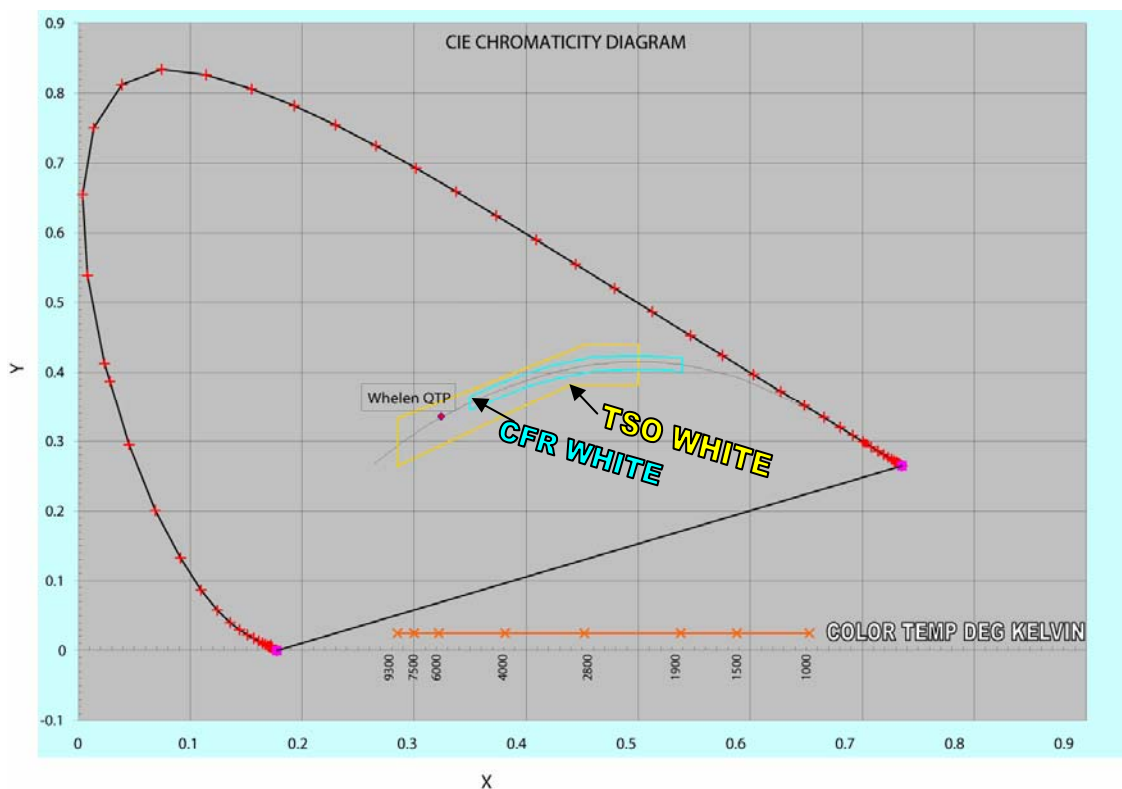


FIGURE 1

BLUE – CFR WHITE LIMITS (§ 23.1397(c) Amdt. 23-N/C)

AMBER – TSO WHITE LIMITS

When installed on the aircraft listed, there are no covers or lenses other than those supplied and qualified as part of the light assembly. The rear position light falls within the applicable color boundary requirements of TSO-C30c, providing an equivalent level of safety.

Based on information provided by Whelen and tests by Cessna, the design and properties of the new rear position light, Model 71011 series, eliminates the need for a periodic inspection, allowing it to be replaced on condition. Its light is derived from six LED(s) wired in series and arranged in a two by three light array. When one LED fails, the entire light extinguishes. Cessna is addressing necessary maintenance practices accordingly in each affected model's maintenance manual. Since the rear position lights on the applicable Cessna Models will consist of several LED elements, in order to assure intensity and viewing angle requirements as the elements age and burn out, prior to delivery of any aircraft with the Whelen LED position lights, Cessna will obtain information from Whelen regarding care of the lights and will include necessary information in the Maintenance Manuals for the affected models.

Photometric testing of Whelen Model 71011 series shows that new light intensity is generally 30% to 60% above the CFR minimums (Reference 14CFR part 23, § 23.1391 and 14 CFR part 23, § 23.1393, per Amendment 23-N/C as included in the model's certification bases). Data from the LED manufacturer (Lumileds) shows a degradation of light output of approximately 22% after 10,000 operation hours. Furthermore these LED(s) tested were operated with higher

junction temperatures than would typically be experienced on the aircraft models listed above. The installation provides very good heat sinking to the aircraft structure, and the environment at altitude provides exceptional cooling. Based on analysis, for intensity degradation, Cessna will recommend replacement of light assembly after 10,000 airframe hours and this limit will be included in appropriate Cessna Maintenance Manual Component Life limit list. Cessna feels this 10,000 airframe hour limit is conservative because the position lights are generally not used during day operation.

These diodes exhibit very little color shift over long periods of time. Chromaticity measurements by the LED manufacturer and the light supplier at 0 and 13,200 hours of operation show the color shifting towards yellow-green (less than .01 for the x or 0.015 for the y coordinates) but remaining within the TSO-C30c color boundaries for white. Furthermore these LED(s) tested were operated with higher junction temperatures than would typically be experienced on the aircraft models listed above. The color shift trend shows that the chromaticity is expected to remain within the TSO-C30c white limits throughout the life of the aircraft with an imperceptible color shift after initial burn in. Furthermore, as this LED system reaches its end of life, the color shift occurs towards the yellow green direction of the CIE color chromaticity coordinates system and still remains within the TSO C30c white which the FAA has recognized within TSO-30c itself as providing an equivalent level of safety. Hence, a pilot would not misinterpret it as a red or green color. Cessna submits that the color white as defined by TSO-C30c meets the intent of 14 CFR part 23, §23.1397(c), Amendment 23-N/C and therefore, an ELOS is justified.

ACO RECOMMENDATION:

The chromaticity requirements are intended to provide, within limits, a standardized perception of “white” to the human eye. The FAA considers that excursion from the 14 CFR part 23, § 23.1397 (c) Amendment 23-N/C requirements for the LED color white, while remaining within the requirements provided by TSO-30c for the color white, provides a light that results in an equivalent level of safety to that required by the regulation. This determination is applicable for the part number listed above and derivative parts from the same manufacturer whose chromaticity is exactly the same as the one discussed here and used on the Cessna Models 172R and 172S. The ACO concurs that the current Cessna Models 172R and 172S rear position light configuration has been analyzed and provides an equivalent level safety for § 23.1397(c) amendment N/C.

RECOMMENDATION:

The certification basis for the Cessna Models 172R and 172S Type Certification Data Sheet TC 3A12 will include an Equivalent Level of Safety finding for 14 CFR 23.1397(c) amendment N/C.

Concurred by:

Margaret Kline

October 26, 2007

Manager, Wichita Aircraft Certification Office, ACE-115W Date

Steven W. Thompson

November 29, 2007

Acting Manager, Standards Office, ACE-110 Date

Pat Mullen

November 29, 2007

Acting Manager, Small Airplane Directorate,
Aircraft Certification Service, ACE-100 Date